

REMARKS

Claims 1-25 are pending in this application. By this Amendment, claims 1 and 12 are amended and claims 21-25 are added. Claims 17-20 have been canceled.

As requested in the Office Action, the legend --Prior Art-- has been added to Figures 1(a) through 3(b) and replacement sheets are submitted for these corrected drawings.

With regard to the drawing objection under 37 CFR 1.84, the follow explanation is provided. The reference numeral “104” in paragraph 0031 has been changed to reference numeral --184--. This was a typographical error in the text. With regard to the reference element 126 shown in Figure 5 that is intended to show a prior art alignment mark, a small box has been added that has a lighter (no) contrast whereas the alignment mark 122 is indicated in a darker contrast.

As disclosed in the specification at page 9, the inventive alignment mark 122 appears more distinct as compared to a prior art alignment mark 126. The alignment mark 122 has better contrast when inspected in an optical microscope. It has a decreased brightness and an increased contrast with respect to a bright substrate. Therefore, the inventive alignment mark 122 is indicated with a darker shade in Figure 5, whereas the prior art alignment mark has a lighter or no contrast. It is respectfully submitted that no new matter has been introduced by this amendment to Figure 5.

The Office Action objects to claim 7-11 as being directed to allowable subject matter, but being dependent on a rejected independent claim. Accordingly, new claims 21-25 have been added that correspond to the original claims 7-11, where claim 21 incorporates the subject matter of original claims 1 and 7.

The Office Action rejects claims 1-6 and 12 under 35 U.S.C. 102 as being allegedly anticipated by U.S. Patent No. 6,628,392 to Kuroda et al. (“Kuroda”).

Kuroda discloses a light modulating apparatus having a periodic structure (“periodic aperture minute slit”) smaller than the wavelength of light emitted from a light source. As shown in Figure 19B of Kuroda, the periodic aperture minute slit is disposed on the front surface of the wafer. Kuroda refers to this embodiment as example 10, and shows a resist film layer deposited on the wafer surface. In the relevant portion of Kuroda’s description for example 10, no further mention is made of this slit. However, from Figure 19B, it is apparent that the periodic aperture minute slit is not part of a resist mask. This is further

supported from the fact that this arrangement disclosed in Kuroda should also detect movements in the z-direction, the direction perpendicular to the wafer surface. Consequently, some mechanical stability is necessary because both the periodic aperture minute slit on the wafer surface and the periodic aperture minute slit on the mask might otherwise be allowed to make contact with each other.

The resist mask according to the present invention is totally different. Specifically, the alignment mark can be formed while patterning the resist layer in order to define resist features that are needed to perform the next processing sequence when manufacturing integrated circuits or similar products.

It is therefore believed that the rejection of claims 1-6 and 12 under 35 U.S.C. 102(e) should be withdrawn. Claims 1 and 12 have been amended merely to clarify that the resist mask is used for measuring alignment on a substrate, and that the patterned structures of the alignment mark are arranged as part of the resist mask having a height which is less than or equal to the thickness of an unpatterned resist layer that forms the resist mask. The alignment marks formed within the resist masks are rendered more clearly visible as compared to other prior art marks on the surface of the substrate during inspection with an optical microscope. In the present application these concepts are described on page 7, paragraph 0024 to page 8, paragraph 0025, and further on page 9, paragraph 0026, and is shown in Figure 6.

The Office Action rejects claims 13-16 under 35 U.S.C. 103(a) as being unpatentable over Kuroda in view of U.S. Patent Application No. 20050041256 to Kreuzer et al. (“Kreuzer”).

Kreuzer discloses an alignment pattern that uses two or more periodic alignment marks of slightly different periods, as well as non-periodic patterns including isolated features and lines or checkerboards of variable but symmetrical patterns. However, Kreuzer makes no teaching or suggestion to replace the alignment mark with a periodic aperture minute slit that is disposed on the front surface of the wafer.

Claims 13-16 depend from now amended claim 12, which is believed to be allowable. Therefore, claims 13-16 should be allowable.

The Office Action rejects claims 1-3, 6 and 12-16 under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,778,275 to Bowes (“Bowes”) in view of U.S. Patent No. 6,417,922 to Dirksen et al. (“Dirksen”) or U.S. Patent No. 5,141,322 to Miyatake.

According to the Office Action, Bowes allegedly shows a structure similar to the features of claim 1, except for the feature of the “resist mask” and the feature that the “lateral spacing is smaller than the wavelength of light used for alignment measurement.” The Office Action refers to column 4, lines 12-32 of Bowes in support of this contention.

Bowes describes a method to aid in the registration of overlying layers in semiconductor devices that are included in each layer of the wafer during fabrication. A reticle is used to pattern the appropriate marks on a particular wafer process layer, such that the marks can be identified by a registration tool in subsequent processing steps. Bowes describes that one example of an alignment mark is a box-in-box mark. An outer box is formed by photolithography and an inner smaller box is formed in a separate photolithographic layering step. When the two boxes are concentric, the layers are accurately registered. As shown in Figure 6 of Bowes, the outer box and the inner smaller box are fabricated on two different layers. Lithographic patterning includes exposure of a resist film layer. However, Bowes does not teach or suggest that the alignment marks are formed as a resist mask. Figure 6 of Bowes merely suggests that the outer box 420 and the line-shaped elements 430, 450, 470 and 490 are formed on a second layer 630 that is covered by a third layer 640.

Furthermore, the marks disclosed by Bowes are not designed to be more clearly visible within the resist mask when inspected with an optical microscope. According to Bowes, the inner and outer boxes are inspected for overlay-registration, while the line-shaped patterns are used to measure optical aberration errors, such as astigmatism, coma, spherical aberration and defocus. Consequently, scatterometry of scanning electron microscopy is needed to inspect the line-shaped patterns. Inspection with an optical microscope of the inner and outer boxes according to Bowes would not reveal a pattern that is more clearly visible, whereas the alignment mark produced according to the techniques and structures of the present invention would be more clearly visible.

Both Dirksen and Miyatake teach the concept of an alignment radiation having a respective wavelength that is larger than the lateral dimensions of the line-shaped patterns

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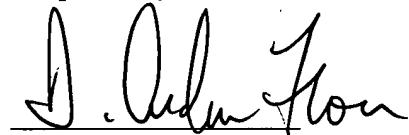
that are taught by Bowes. However, there is no motivation for a person with ordinary skill in the art to combine the teachings of either Dirksen and Miyatake with Bowes. Bowes describes structures used for scatterometry or scanning electron microscopy where the longer wavelength of the alignment radiation does not influence this result.

The present invention is directed to a completely different concept. According to the invention, the alignment mark is formed as a resist mask having a height that is less than or equal to the thickness of the unpatterned resist layer, and having a lateral dimension that is less than approximately half of the wavelength of light used to perform the alignment measurements. These features taken as a group impart an overall shape, size and apparent border to the mark as it appears to the observer using an optical measurement instrument. In addition, these features help to determine other aspects of the appearance of the mark, e.g., the color, brightness and sharpness of it. This concept is not shown or suggested in any of the cited references. For these reasons, independent claims 1 and 12, and the claims that depend from them, should be patentable over and above the cited references.

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No extension of time or other fees are believed to be due, except as detailed in the attached documents. However, Applicants hereby petition for any extension of time that may be necessary to maintain the pendency of this application. The Commissioner is hereby authorized to charge payment of any additional fees required for the above-identified application or credit any overpayment to Deposit Account No. 05-0460.

Respectfully submitted,


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Amendments to the Drawings:

The attached sheets of drawings include changes to 1(a) through 3(b). These sheets, which include Figs. 1(a) through 3(b) and Figure 5, replace the original sheets including Figs 1(a) through 3 (b) and Figure 5.

Attachment: Replacement Sheets